Mexican Wolf Blue Range Reintroduction Project
Adaptive Management Oversight Committee
Standard Operating Procedure

Title: Aerial Telemetry
Number: 18.0
File Name: MW SOP 18.Aerial Telemetry.Final.20051030.doc

Purpose: This SOP provides context for conducting aerial telemetry, as well as describing specific techniques and record-keeping procedures. It supersedes relevant sections of the 1998 Mexican Wolf Interagency Management Plan (USFWS 1998), and therefore represents, in part, the "Service Approved Management Plan" referenced in the Mexican Wolf Final Rule (50 CFR 17.84(k)).

Note: As noted in SOP 1.0, Reintroduction Project SOPs are developed with cooperation from the White Mountain Apache Tribe and the San Carlos Apache Tribe for the benefit of the overall Project. However, on tribal lands any Project activities are governed by tribal authorities, laws, rules, policies, etc. and Statements of Relationship between each tribe and the U.S. Fish and Wildlife Service. Thus, IFT aerial telemetry activities may only be conducted on Tribal lands with prior approval by the appropriate Tribal authorities.

Exceptions: None. Per SOP 2.0, AMOC must approve any exceptions to this SOP.

Background: Aerial telemetry using fixed wing aircraft is vital for successful wolf management and monitoring. The Project uses aerial telemetry to complement ground telemetry efforts (see SOP 17.0), tracking dispersing wolves, monitoring new pack formation, den and rendezvous site locations, aversive conditioning, mortality investigations, and depredation investigations. It is vital that the IFT be proficient using the equipment, collecting accurate locations, and processing data correctly (see Appendixes A and B). Telonics Quarterly (1997) describes aerial telemetry equipment and techniques (see Appendix C).

Procedures:

1. Prior to performing aerial telemetry.

    a. Ensure that you have received the appropriate Aviation Safety training if required by your agency prior to flying. For their personnel, USFWS requires training provided by the Office of Aviation Safety.

    b. Anyone who will be trained in aerial telemetry should go on several flights with experienced personnel in order to:
        i. Evaluate your propensity for motion sickness from low altitude flying, turbulence or tight circling for extended periods.
        ii. Gain familiarity with the landscape from the air.
        iii. Learn the procedures outlined in this SOP.

c. Make sure you have the following items:
   i. Receiver.
   ii. Ear piece.
   iii. Metal H-antenna (and spare).
   iv. Spare coaxial cables.
   v. Flight sheet (Appendix A), including the last location of each wolf.
   vi. Maps of the area, if you are unfamiliar with the geography.

d. Coordinate with the pilot to establish a flight plan and objectives.

e. The appropriate State or Tribal Interagency Field Team Leader will provide a schedule of routine flights to the Southwest Coordination Center (SWCC) (505) 842-3473. AGFD will provide contact frequencies to SWCC as well. If routine flights are rescheduled due to weather or other considerations the pilot, observer or AGFD 24 hr dispatch will notify SWCC of the changes. SWCC will notify the appropriate USFS Forest Zone dispatch of pending aircraft activity. The purpose of this coordination is to mitigate potential airspace conflicts with other known agency aircraft operating in the same area. Pilots are also responsible for checking NOTAMs for any Temporary Flight Restrictions (TFR) or other airspace issues.

f. Whenever possible, flights over wilderness/primitive areas will be at least 2000 feet above ground level.

g. Be familiar with emergency equipment on the airplane and safety restrictions (e.g. helmet and flight suit for low level flying and location of the Emergency Locator Transmitter (ELT)).

2. Determining Locations.

   a. General guidelines.
      i. The pilot always makes the final decision as to when to fly and for how long and how low. The observer can make suggestions, but must leave the final judgment up to the pilot.
      ii. Scan for missing wolves any time you are not actively locating another wolf.
      iii. Determine which wolf or pack will be next in the flight path, and scan using the wing antennae.
      iv. When a wolf is heard, have the pilot scan the area using S-turns to generally determine a wolf's location. If the signal is on mortality mode, see SOP 12.0.
      v. Fly in the direction of a wolf until you hear the signal from the belly antenna.
      vi. By turning the belly antenna, you can determine the exact direction the wolf is from the airplane. Fly a pattern until the signal only comes from the right side of the plane as you fly in tight circles.
      vii. Watch the landmarks on the ground to determine the exact location of the wolf.
      viii. Mark the GPS when flying over that point to record the wolf's location.

ix. Check other wolves in the same pack, or that might be in the same area, to determine if they are together.

x. Visually survey the area for both collared and uncollared wolves, pups, signs of a carcass, or human presence in the area, by flying circles over the area for several passes. If a kill is observed from the air, note any relevant information and consult SOP 11.0 prior to an intensive investigation.

xi. Continue the process with other wolves until the flight plan is completed.

xii. While in the aircraft, either between each location or on the ground at the end of the flight, record the following on the Flight Sheet (see Appendix A):
   (1) The time of the location.
   (2) The location of the wolf in Latitude and Longitude.
   (3) Any important or unusual observations.

xiii. If you cannot locate a wolf:
   (1) Be sure you are using the correct frequency and the wing antennae. Periodically adjust the frequency, in case the collar has malfunctioned.
   (2) Go to the wolf's last known location and begin flying circles using that point as the center. Fly 3, 5, 7, or 10-mile loops, depending on time available, fuel, and time since the wolf was last located (i.e. the greater the time since it was last located, the larger the loop should be).
   (3) Altitude affects the range at which you can hear the signal, so the higher you can fly, the better your chance of hearing the wolf. Observe restrictions on altitude imposed by the pilot or agency. AGFD pilots may not operate above 13,500 feet for more than 30 minutes without supplemental oxygen.
   (4) If, after following the above steps, the wolf is not located:
      (a) The search can be abandoned for this flight. Be sure to notify the IFT about which wolf was not found and the search you performed.
      (b) On the next flight, scan for this wolf whenever you are not actively locating another wolf.
      (c) If the wolf is not located for two consecutive flights, a search flight may be scheduled specifically to locate the missing wolf.

3. Data transformation and mapping

a. As soon as possible after the flight (not more than 3 days), Using Terrain Navigator, the person who flew should:

i. Set preferences to: Coordinates D M.M, Datum WGS 84.

ii. Go to Markers/Define/edit and click "new."

iii. Enter each location using the following format:
   (1) Name the marker dd/mm Pack Studbook number (individual ID number), (e.g. 6/30 FR509)
   (2) If the location is for more than one animal in a pack, omit the studbook number, naming the location for the pack, for example 6/30 Francisco.
   (3) Enter the lat/longs and click OK.
   (4) Enter all locations for all wolves beginning at Step 3.a.ii.

iv. Change preferences to: Coordinates UTM, Datum NAD 27.

v. Click on Markers/Go to and select a marker.

vi. Right click on the marker to obtain the UTMs of the location and write them on the Flight Sheet.
vii. Using the ruler tool, determine the distance and direction from a prominent landmark (or two) and note this on the Flight Sheet.
viii. Continue from Step 3.a.v. until all locations are completed.

4. Copy information from the Flight Sheet to a Location Sheet (see Appendixes A and B) for each wolf.

5. Entering the location into the Database.

   a. Open the Mex Wolf database file under the Start button on the main computer in the IFT office.

   b. Under the open existing database button, click on C:\Alldata\zip disk from old pc\…\db1

   c. Click on the data entry button.

   d. Click on the location sheet button.

   e. Enter the appropriate data in the form from your data sheet. Ask questions if you do not understand this process.

   f. Record in the daily journal a general description of where each wolf or pack is located, including which state.

   g. Save the Journal under the appropriate date for that file.

   h. Send an e-mail to the "Journal List" with brief descriptions of each wolf location. Specific directions on who to send the journal to and who else to notify with locations are provided on the wall above the computer.

6. Put your data sheet in the location file of the appropriate wolf number.

Approvals:

The Mexican Wolf Blue Range Reintroduction Project Adaptive Management Oversight Committee approved this SOP on October 10, 2005.

References:

Telonics, Inc. 1997. Telonics Quarterly v.10 n.1.

Appendixes:

Appendix A. Note: This image should be flipped with the bottom facing right.

Frequency	Wolf ID	Pack	Time	Latitude	Longitude	Comments	Easting	Northing
	AF 486	Hawk's Nest						
	AM 619	Hawk's Nest						
	AF 587	Bonito Creek						
	M 794	Bonito Creek						
	AF 487	Cienega						
	AM 194	Cienega						
	m 795	Cienega						
	m 796	Cienega						
	AF 521	Bluestem						
	AM 507	Bluestem						
	AF 510	Saddle						
	AM 574	Saddle						
	AF 511	Francisco						
	AM 509	Francisco						
	m 798	Francisco						
	f 799	Francisco						
	f 800	Francisco						
	m 801	Francisco						
	AF 562	Luna						
	AM 583	Luna						
	AF 624	Gapiwi						
	AM 584	Gapiwi						
	m 729	Red Rock						
	m 732	Red Rock						
	m 832	Single						
	f 797	Single						
	AF 637	Hon-Dah						
	AM 578	Hon-Dah						
	Lost Collars							
	F 621	Singe--NM		M 627 - 6011	Pipestem			
	F 189	Mule		M 555 - 055	Gavilan			

Appendix B.

Wolf ID________________________ **Pack_________________________**

Date_____________ ___________ **Time__________** **Aerial or Ground**

UTM-East: 12 S ________________ UTM-North: ___________________

Comment on location____

____

Personnel____

Miscellaneous____

____

____

____

Total # seen____ (# pups____ # adults____) Rest Move Feed N/A

Howling/barking-duration______________ # of wolves________ # pups? ______

Time Azimuth Location of Azimuth Signal Quality

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____

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____

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____

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No Triangulation **Poor (>1 km^2)** **Good (<1 km^2)** **Visual**

Appendix C.

The following articles provide good background and reference information for anyone using aerial telemetry or tasked with setting up an aerial telemetry system on an airplane. These two articles are reprinted herein from *Telonics Quarterly* 1997, by permission of Mr. Stan Tomkiewicz, Telonics.

Fixed-wing aircraft tracking.
For someone new to the field of wildlife telemetry, tracking animals from fixed-wing aircraft may seem a rather unusual approach. For anyone who has actually spent time tracking animals, it is a well known technique to climb up a hill or mountain to extend the range of your telemetry system. The use of aircraft simply extends the principle and provides some added mobility as an extra.

If you're ground tracking a medium sized animal wearing a collar with a state-of-the-art telemetry receiver (such as the TR-2 or TR-4) the range performance on level ground can be anywhere from 2 to 5 miles. By getting up on a hill and overlooking the animal, ranges can be extended to 5 to 10 miles. However, if it is possible to take your telemetry receiver up in an aircraft, the range is extended even further—typically from 10 to 30 miles.

For many studies, regular aircraft tracking provides the data to remain in constant contact with animals that move over extensive areas. It extends the line-of-sight range and reduces signal attenuation due to vegetation. These two factors, combined with aircraft speed and mobility, provide significant advantages. The technology supports both small studies operating on a shoe-string budget and large statewide efforts to monitor large animal populations.

Conducting research from aircraft is recognized in our field as a dangerous operation. Over the years far too many friends and colleagues have been injured or lost in aircraft accidents. Therefore anything that increases efficiency, and reduces the time spent conducting low level flights, should have a positive influence on our actuarial statistics. This newsletter has been dedicated to providing some options, procedures and hopefully helpful hints, that will make tracking animals from fixed-wing aircraft a little more efficient, and safer process. *Editor*

Antenna Mounting

Brackets

Step-by-step, here's how to do it.
Tracking wildlife from fixed-wing aircraft has become almost routine and numerous approaches have been tried to solve the problem of connecting tracking antennas to aircraft. There are several treatises in the literature and in technical notes published by various state and federal agencies concerning the "best" technique for attaching antennas to various aircraft. In most instances the resourcefulness of the researcher pays off—and whatever technique is employed usually ends up successful if not always efficient. If you have a favorite technique and it works, continue to use it. We are not going to try and convince you to change and use the approach presented in this issue. Wisdom says never argue with success.

If you’re having trouble getting the gear you require manufactured, however, or if the technique you are using seems to be less then consistent, we are going to suggest an alternative approach. The setup and techniques we describe may help make aircraft tracking a bit more consistent, a little less time consuming and perhaps a little safer. In this article we will address the choice of antenna brackets, installation of the brackets on the aircraft, and attachment of the antennas to the brackets.

Our discussion is directed to the use of the Telonics RA-2A antenna and the TAB series of antenna brackets because many researchers have successfully implemented this approach with essentially “off the shelf” equipment. The TAB brackets were designed specifically to secure the R A - 2 A antenna to the struts of the high wing aircraft without requiring permanent modification of the aircraft. In fact the whole system can be mounted to or removed from an aircraft in a matter of minutes. This works well when rental or contract aircraft are utilized.

Antenna bracket choices range from the TAB-1 (typically fits Cessna 150 and 172 aircraft) to the TAB-6 (fits the Christen/Aviat-Husky). The critical parameter in choosing an antenna bracket is the size of the strut—and measuring the strut is important.

Often a particular model of aircraft will have a larger engine, requiring larger struts. So picking a set of brackets “off the shelf” simply by model number of the plane does not always work. Therefore, in addition to the aircraft model number, actual dimensions of the strut are required. The first strut dimension needed is (A), the distance from leading edge to trailing edge. The second is (B), the thickness of the strut at its thickest point. The third is (C), the circumference. Please refer to Table 1 for more specific information on
typical strut dimensions and models of aircraft.

After you have selected the correct brackets, it is time to install the equipment on the airplane. The first step is to gather and identify all of the equipment to be installed (i.e. left and right TAB brackets, RA-2A antennas, coaxial cables, TAC-2 or TAC-7 antenna switch box and, finally, either the TR-2 or TR-4 telemetry receiver).

If the aircraft is a rental and the coax cable installation is temporary, the cable installation should be delayed until after the brackets and antennas have been installed. If the aircraft is dedicated to the project, the best place to dress the coax cables is through the wing into the cabin. In this manner, you assure the longest operational life of the cables since they w o n ’t be exposed to wind, sun, and precipitation. An installation such as this can be made by installing a bulkhead connector (CON-BNC/BNC-THN) in an inspection plate in the wing, routing the coax up into the wing on both sides of the aircraft and then into the cabin. When this type of work is done, be sure that a certified A&P mechanic either works with you, or inspects your work, and then signs it off in the log book. *If your aircraft is pressurized, you should take special care to use pressure rated bulkhead connectors when going from the wing into the cabin.*

Each antenna bracket is individually marked “right” or “left” with respect to a person sitting in the cabin of the aircraft. Install the brackets on their respective wing struts centered between the fuselage and the attachment point of the strut to the bottom of the wing (see Photos 1 and 2). The “V” sections of the brackets must be on the outboard side of the strut, making certain the strut and strut clamp profiles match. *This is critical since this interface provides stability for the bracket and* *antenna assembly.*

Adjust the “V” of the bracket so that the strut clamps mount squarely on the strut. The brackets should be mounted identically on each side of the aircraft. At this time the rear strut clamp screws can be tightened (if so equipped) and then the front strut clamp screws can be tightened. Do not over-tighten the screws. The brackets should now be securely mounted to the strut.

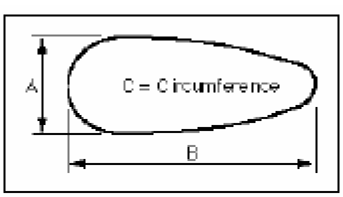
Mount both antennas with the BNC connectors facing up and outboard from the aircraft (see Photo 2). Tighten the antenna lock nut until it is snug and then use nylon cable ties to secure the antenna to the bracket panel (see Photo 3). Tighten each element securely with a small wrench, being careful not to over- tighten the elements since a broken element causes great aggravation! Tape each element joint tightly with electrical tape so the elements don’t rattle loose and get lost during the flight (see Photo 4).

For those doing a temporary installation, you can now attach the coaxial cables to the antennas and route the cables over to the strut and down the trailing edge of the strut, securing the cable every 6 inches with nylon cable ties (see Photo 5). Use duct tape to secure the cable to the outside of the fuselage before entering the cabin through a door, window or air vent. Make certain that the cable will not be crushed when the door or window is closed. *It’s advisable to purchase or make a spacer that will prevent the cable from being crushed.* The cable integrity is crucial and if the cables are damaged or smashed, the success of the mission may be jeopardized.

Once the cables are inside the cabin, route them to the area where they will be connected to the TAC-2 or TAC-7 switch box. Be careful that the routing of the cables does not interfere with other control cables or wiring (see Photo 6).

Now that the installation is finally done, it is a good idea to inspect the brackets, cables, and antennas for proper installation. Conduct a short test flight to check for flutter or vibration. A flight test can be done by placing a spare transmitter close to the airport in a known location— so that you can fly a test pattern around the beacon and test the function of the switch box and antennas before flying 100 miles to your research area. Flight characteristics of the aircraft should be normal, with a slight amount of parasitic drag.

REMINDER Regulations governing the attachment of equipment to aircraft vary depending on ownership, use and location. Users should check with appropriate authorities regarding current regulations. The International Association of Natural Resource Pilots is a source that can make suggestions based on practical experience. You may also wish to refer to the Federal Aviation Regulations concerning type certification requirements. *Gary Jones*



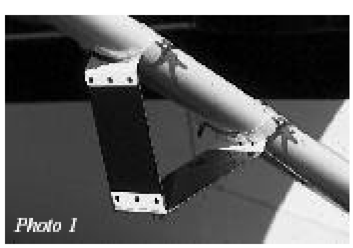


Photo 1


Photo 2

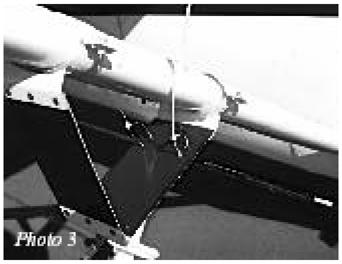


Photo 3


Photo 4


Photo 5


Photo 6

Table 1: Bracket Dimensions and Aircraft Models

BRACKET NUMBER	DIMENSIONS A	B	C	COMMON AIRCRAFT
TAB-1	4.75"	2.06"	11.00"	Cessna 150, 172
TAB-2	5.75"	2.44"	13.50"	Cessna 206, 207, 185
TAB-3	3.88"	1.63"	8.75"	PA-22 (Tri Pacer), BC-12 (Taylor Craft), PA-18 (Super Cub)
TAB-4	2.38"	1.38"	6.00"	J3 (Piper Cub)
TAB-5	5.00"	2.19"	12.00"	Cessna 182, 150-Aerobat
TAB-6	3.37"	1.43"	8.00"	Christen/Aviat-Husky

Aircraft Tracking

Recommended aircraft general search pattern.

In recent years we have noted an increasing application of fixed-wing aircraft in radio location studies. The flight pattern described below represents a standard procedure developed and recommended for radio location of terrestrial animals. This pattern is by no means the only successful one currently in use. Many variations exist that incorporate specific geographical features or animal behaviors, or that take advantage of previously acquired information about the species in question. However, for those individuals who have been experiencing less than successful aircraft relocation efforts, or those just beginning to utilize aircraft in radio telemetry work, an examination of this basic pattern may be worthwhile in time, effort, and dollars expended.

General search efforts for terrestrial species are usually conducted with the Telonics TR-2/TS-1 scanning receiver, TAC-2 RLB antenna control unit, and a pair of RA-2A “side-looking” antennas (see Figure 1). The expected range for signal acquisition depends on several factors—one primary factor being altitude above ground level (AGL). The theoretical relationship between range and AGL is defined in Figure 2.

Such range performance can be achieved using a high power option and a dipole antenna on large animal transmitters. For standard transmitting subsystems with monopole antennas, the range is approximately one half of that predicted in Figure 2, and range may be less when using low power or small animal transmitters. The following steps offer a general description of the search pattern as illustrated in Figure 3:

A. When a signal is detected, the scanner is stopped on the frequency of the incoming signal. The TAC-2 is then used to determine whether the signal is on the right or the left of the aircraft by monitoring first the left antenna, and then the right, to determine which is receiving the strongest signal.

B. Assuming the signal is strongest on the right side, the pilot begins a slow 360° turn. This results in tilting the left wing down by 30°, thus placing the maximum gain of the right antenna on the horizon. The signal is monitored from the right antenna only during this period and a note of the bearing direction is made when the signal strength is at its maximum. The plane is brought out of the 360° turn on the noted bearing.

C. The transmitter should now be located directly ahead of the plane, but at some unknown distance. The switch box is utilized to keep the plane on course. If either antenna is picking up a signal, the course is slightly adjusted to keep the transmitter in the null.

D. Flying the null of the antenna pattern can be disconcerting at first. In order to increase the confidence of the user, a second bearing can be taken by banking the aircraft to the left in a slow turn. Once again the pilot dips the left wing down 30°. This tips the right wing up 30°, placing the gain of the right antenna on the antenna.

E. A second bearing is taken and quickly compared to the first. The intersection of the two represents the theoretical location of the animal.

F. The pilot then resumes course toward the transmitter. As the aircraft approaches the transmitter, the null disappears and the signal must be kept equalized between the two antennas. The actual point of signal acquisition when the transmitter is directly in front of the aircraft is dependent on several factors, including AGL. Figure 4 depicts the change in signal strength as function of A G L as the aircraft approaches, passes directly over, and goes by the transmitter. An altitude of 1000 to 1500 feet A G L is recommended for precise locations.

NOTE: *As the aircraft passes over the transmitter, the gain of the antenna (as a dipole) is placed directly on the transmitter. As the signal saturates the receiver, the audio output of the receiver may change from a "beep" to a plodding or "thud" sound.*

G. After passing directly over the transmitter, the aircraft is banked to the right to begin a 360° turn. The PILOT's wing tip is now up 30°. Since the antenna is initially attached to the strut at a downward angle of 30° from the horizontal, the combined effect is a right antenna that is now 60° down from the horizontal. The maximum gain of the right antenna is pointed directly at the center of the area being circled. The animal should be in the center of the circle and the receiver should be supersaturated with signal.

H. Upon completion of the monitoring process, the frequency of the transmitter can be deleted from the program of the scanner/receiver and the search for other transmitter s resumed. Although the technique described above may appear to be time consuming and complicated at first, its effectiveness has been proven time and again throughout the world. The search pattern is most effective when there is constant cooperation and communication between pilot and biologist. After a short time, the procedure becomes almost automatic. In several studies this procedure, coupled with frequency stable receiver and transmitter subsystems, has reduced flight time by up to seventy percent. The result is substantial reductions in budgetary expenditures associated with tracking wildlife from fixed-wing aircraft.

Dave Beaty and Stan Tomkiewicz

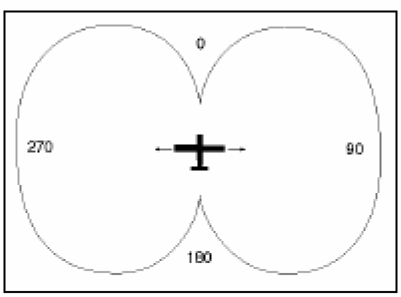


Figure 1. Aircraft Antenna Pattern Utilizing Paired Side-Looking RA-2A Antennas

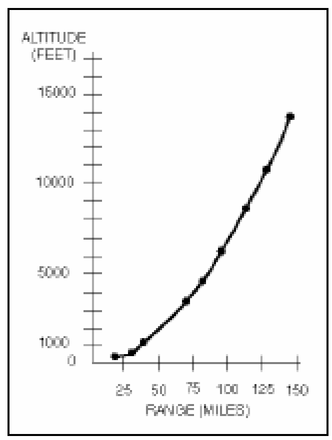


Figure 2. Relation between Aircraft Altitude and Radio Horizon

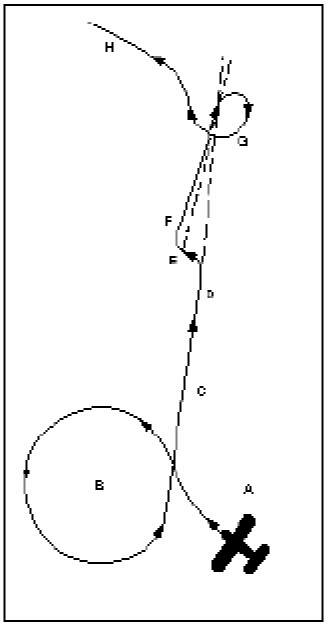


Figure 3. Aircraft Search Pattern

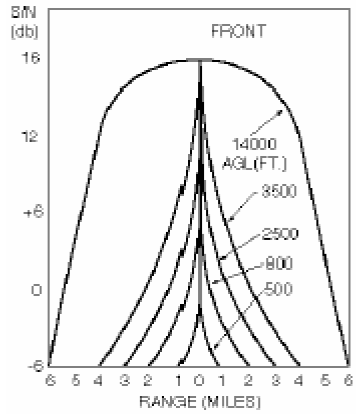


Figure 4. Signal Strength Expressed as Signal to Noise Ratio in db Versus Range to the Transmitter Directly in Front of and Behind the Aircraft.